STEM

SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS

21ST CENTURY IMPLEMENTATION PLAN

PRESENTED TO:

Interim Joint Committees on Appropriations and Revenue and Education

BY

Kentucky Council on Postsecondary Education

STEM Task Force

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IN PROGRESS

Kentucky UNBRIDLED SPIRIT

KENTUCKY COUNCIL ON POSTSECONDARY EDUCATION

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Foreword

The Kentucky General Assembly enacted legislation during its 2008 session, referenced as Senate Bill 2 (KRS 164.0287), which focuses on strengthening Kentucky's workforce talent in Science, Technology, Engineering, and Mathematics (STEM) disciplines. The statute formally established the STEM Task Force giving it the responsibility to address former Council on Postsecondary Education STEM Task Force recommendations made to the legislature in March 2007 with an implementation and business plan as follows:

> ***"…explore the critical relationship between STEM degree production and the knowledge-based economy of Kentucky and make recommendations to accelerate Kentucky's performance in the STEM disciplines. The task force shall develop a comprehensive, statewide strategic plan and a business plan to improve STEM performance in government, business, elementary and secondary education, and postsecondary education… The initial business plan shall be presented to the Interim Joint Committees on Appropriations and Revenue and Education by December 30, 2008. In subsequent years, the task force shall review and revise the business plan as needed to further the purposes of the STEM Initiative."***

Kentucky STEM initiatives to date have focused on promoting and improving education in the areas of science, technology, engineering, and mathematics to prepare students for college and pursue STEM-related careers. However, workforce projections show that 75 percent of the fastest growing occupations require significant science or mathematics training to successfully compete for a job and according to the U.S. Bureau of Labor Statistics, information technology jobs will increase 24 percent by 2016. Kentucky's K-20 educational reforms have made great strides in addressing student preparedness for work and college through targeted STEM initiatives. In order

to be globally competitive, Kentucky must build on best practices learned from research-based programs, and utilize successful pedagogy to expand efforts in STEM education.

Recognizing the challenging financial situation facing the state, this STEM Implementation Plan focuses on facilitating the expansion of a number of programs and strategies with proven results, and taking the steps necessary to drive their utility throughout the Commonwealth. The Plan calls for assessing the current use of professional development funds, redirecting those funds where necessary to accomplish the goals outlined herein, targeting new investments, and further engaging business, industry, and civic leaders to improve STEM education and skills, creating incentives from partners that employ and invest in STEM-educated professionals.

Background

Senate Bill 2 (KRS 164.0287) reflects the General Assembly's recognition that Kentucky's prospects for long-term economic success depend on its ability to produce a workforce with the skills necessary to compete in the 21st Century economy. According to the U. S. Bureau of Labor Statistics over the next six years, job growth of 27 percent or more will occur in computer science, database administration, software engineering, biomedical engineering, environmental engineering, healthcare, medical research, and internet publishing. The evidence that Kentucky needs to better prepare itself for these changes is abundant. For example, the Progressive Policy Institute ranks Kentucky in the lowest quartile in workforce education, number of scientists and engineers, number of patents, high-tech jobs, industry investment in R&D, and number of fastest growing companies, all economic growth indicators for increasing state income.

The American primary and secondary educational systems have been under increasing criticism for inadequately preparing students for employment. Critics argue that the system holds constant time spent by each pupil (12 years), instead of assuring that all pupils meet the same external standards of accomplishment. Kentucky's challenge is stark, but hardly unique. Entities like the Gates Foundation, the U.S. Chamber of Commerce, the National Association of Manufacturers, the National Academy of Sciences, the National Center on Education and the Economy, the National Governors Association, the Business-Higher Education Forum, and others have produced reports in recent years pointing to a national crisis in STEM education and calling for fundamental change in education systems.

In Kentucky, the Kentucky State P-16 Council, Kentucky Chamber of Commerce, Kentucky Association of Manufacturers, Kentucky Society of Engineers and P-20 educators have all expressed the need for collaborative public-private partnerships to address the STEM education imperatives for Kentucky.

Original Task Force Recommendations

The General Assembly's vision for STEM in Kentucky was spurred, in part, by the Kentucky Council on Postsecondary Education (CPE) creation of a Science, Technology, Engineering, and Mathematics Task Force (STEM1) in November 2006. That Task Force was charged *with developing a statewide strategic action plan to accelerate Kentucky's performance with the STEM disciplines. Recommendations and accountability measures also need to explore the relationship between STEM production and the creation of knowledge economy or 'talent force' jobs, the commercialization of intellectual property, and innovation within Kentucky.*

The initial STEM Task Force was chaired by University of Kentucky President Lee Todd and included 110 members representing government, business, and education sector stakeholders. This initial Task Force membership brought a sense of urgency to their work, producing a report and set of recommendations in March 2007. (http://cpe.ky.gov/news/reports/cpe_reports/stem.htm).

Senate Bill 2 (SB2, i.e. KRS 164.0287)

The General Assembly formalized the STEM Task Force through SB2, recognizing the need to sustain the original 2006 Council Task Force's work. This group includes representatives from all sectors of Kentucky's education system, as well as business, industry and civic leaders as engaged stakeholders. (Appendix I.) University of Kentucky President Todd continues to serve as Chair, along with Vice Chair, Deborah Clayton, Commissioner of the Kentucky Department of Commercialization and Innovation in the Cabinet for Economic Development.

Investing in Kentucky's Future

The 60 member STEM2 Task Force first met in June 2008 to further develop an Implementation Plan. The eight original recommendations were studied further and regrouped around four main emphases: public awareness and promotion, professional development, curricula alignment, and partnership engagement. Assigned to four workgroups charged with developing strategies for implementation, the workgroup chairs challenged each workgroup to address "now" priorities. Each workgroup returned their priorities which coalesced in the short term around very substantive strategies. A fifth workgroup continues to determine funding resources, analyzing current uses and future needs.

The critical components of the STEM2 Task Force recommendations include a strong emphasis on P-20 collaborative work with business, industry, and civic community leaders. A chasm between education and employer needs in the 21st Century must be bridged with a heightened public awareness related to the critical need for STEM literacy. This literacy involves teaching a rigorous STEM curriculum and aspiring to ever increasing competencies in STEM disciplines. Teacher education must focus on enhanced STEM disciplined and embedded pedagogy. Both current and future educator training and development programs must be aligned with 21st Century skills as identified by current and prospective workforce employers. Kentucky's STEM educational efforts must be enhanced by external sectors including financial support, experiential opportunities, and outreach throughout the P-20 educational community.

The following priority strategies focus on the priority recommendations of the workgroups beginning with acknowledgement by all Kentuckians that they share responsibility to bring about a dramatic culture change with regard to STEM preparedness and its importance to Kentucky's state, national, and global economic competitiveness. Estimates with projected time, cost, metrics, and suggested responsible parties are provided. (Appendix II.) These are the immediate identified challenges that may propel Kentucky's students and workforce toward life and work preparedness in the 21st Century.

Challenge #1

Provision of societal support and partnering by all STEM education stakeholders through increased awareness regarding the importance of STEM discipline opportunities to Kentucky's viability and future economic survival and prosperity.

Strategy I.

STEM public awareness and promotion through development of a STEM communications framework, creating awareness and encouraging involvement of all stakeholders, including a branded marketing plan and Web site that cross links educators with community partners through education, business and government sectors providing aggressive multi-media exposure of the STEM challenge and opportunities for success.

Desired Outcomes:

A Kentucky STEM Web link and brand, utilized by all sectors and aligned with KnowHow2GoKy campaign activities regarding teacher certification, STEM tutorials and course access, business mentors and experiential opportunities, standards for teaching, competencies for all educational level attainment, scholarships, partner incentives, and much more.

Challenge #2

Scale STEM initiatives that are research-based successful models statewide through adoption of "Best Practices" by all Kentucky P-12 educators with provision of professional development opportunities to accompany them. Traditional pedagogy with few applications to life and work has left many Kentucky students lacking competencies needed for college, a career, and life in the 21st Century.

Strategy II.

Expand Kentucky's STEM talent through Project Lead the Way (PLTW), AdvanceKentucky, and Primary Mathematics Implementation Programs to provide successful teacher preparation and student learning.

Project Lead the Way (PLTW) (http://www.pltw.org/index.cfm) is a nationally-recognized middle and high school curriculum that focuses on project and problem based contextual learning aimed at cultivating student interest in pursuing careers in engineering and engineering technology. PLTW currently focuses on the development of STEM skills preparing students for pre-engineering, bio-medical, and energy-related postsecondary education. The success of PLTW depends on partnerships involving middle and high schools, colleges and universities, and the business sector. During both 2006 and 2008 sessions, the Kentucky General Assembly appropriated funds to begin implementing PLTW in Kentucky. To date, 94 schools have registered to participate, but only 28 schools have implemented the program. There are 450 middle and high schools statewide.

Focusing on statewide implementation of PLTW makes sense. Despite the limited utilization to date, considerable data have been accumulated indicating the success of PLTW in Kentucky:

- 80 percent of current high school seniors in PLTW programs plan to go to college (the average in Kentucky is 63 percent).

- 40 percent of former PLTW participants are studying engineering in college.
- Across all demographic groups, PLTW students are more likely to go into STEM majors in college than other students.

PLTW is available to all students regardless of prior learning. Implementation in middle and high schools is straight-forward with few components that involve curriculum changes, continuous professional development for teachers, and equipment/software installation, all components of education serving a knowledge-based economy.

The key component of PLTW is that every participating teacher must go through extensive and on-going training provided by Kentucky's colleges and universities. Teacher training takes place through summer institutes and "virtual academies," offering professional development and graduate education credit.

Expanding PLTW to all of Kentucky's middle and high schools by 2020 and maintaining the program across the state would cost an estimated $5 million annually. This includes start-up costs and professional development funds.

AdvanceKentucky (http://www.kstc.com/?665) is a statewide math-science initiative dedicated to helping Kentucky's students reach new heights in rigorous academic achievement. Begun in 2007, this is a six-year partnership between the Kentucky Science and Technology Corporation (KSTC) and the National Math and Science Initiative (NMSI). In addition to having critical start-up endorsements from both the executive and legislative branches of Kentucky's state government, key start-up partners also include the Kentucky Department of Education, Kentucky Council on Postsecondary Education, Partnership for Successful Schools, and the Appalachian Regional Commission.

By taking the highest level of college preparatory mathematics students are capable of successfully handling in all four years of high school, they will develop a solid background in math skills and concepts, will be prepared to succeed in the entry level mathematics course in college, will avoid regression between high school and college by taking math each year of high school, and will have a solid background for engineering/technology.

Under conditions of matching over the six years, NMSI has committed $13.2 million to AdvanceKentucky through funding from the Exxon Mobile Foundation. Kentucky must match this funding. Eighteen schools participated in the 2008 cohort with an additional 12 schools added in the 2009 school year. *Elements of success* in the NMSI model, shared in documented research conducted with teachers, faculty, and students, are included in Kentucky's work, coordinated by the Kentucky Science and Technology Corporation.

To fully utilize $13.2 million committed from the National Math and Science Initiative (NMSI) another $13.2 million is needed in matching over five years (2007/08-2012/13). To date, commitments of other grants and contributions total an estimated $5 million of the needed match. NMSI 'requires' matching contributions starting in year three, with FY 09/10 set as the target year for beginning to secure more match going forward. Confirming match throughout the grant period will provide greater long-term security of the program and access to NMSI funds over a longer period of time. Based on early indicators and commitments from schools, teachers and students, the NMSI model can produce significant returns in the dramatic development of Kentucky's STEM talent force.

In addition to direct matching for AdvanceKentucky, restoring recent professional development cuts or pursuing other sources will be needed in producing matching contributions and growth of the program. Bringing schools into the program as "partners" to share expenses is a commitment and infuses this model

into existing school systems to establish a much better chance of it being sustained long-term.

Supporting the NMSI "Elements of Success" is an investment in reducing barriers to student success (such as covering costs of the AP exam fees, experiencing quality "pre-AP" courses that better prepare students for the rigor of AP, and more time-on-task for students to master rigorous coursework), developing teacher talent and depth of content knowledge *continuously* (for both beginning and master teachers), and vertical teaming in the content areas for long-term impact.

A few early indicators of impact of AdvanceKentucky Cohort 1 Schools:

- Enrollments in AP math, science and English have doubled to 2,200 in the 2008/09 school year compared to pre-program baseline 2006/07 numbers.
- 2008 AP exams resulted in Cohort 1 schools' math, science, and English qualifying scores contributing 10 percent of Kentucky's *statewide* growth in AP qualifying scores (all subjects), even though these 12 AdvanceKentucky schools represent only 5.5 percent of Kentucky's 234 high schools reporting AP scores in all subjects.

Based on preliminary start-up estimates which will be refined and utilized in program expansion to more schools, the average annual cost of supporting a school participating in the AdvanceKentucky/NMSI Model is approximately $95,000 but this can range widely depending on the size of the school and its AP program. This covers multiple teacher professional development and AP course development throughout the year for AP and pre-AP teachers in the high school and feeder middle school(s). The model supports AP exam fees, lead teachers/mentors, teacher stipends for more work involved in offering AP courses and providing more time-on-task for students, incentives for students, teachers, and schools, and administrative support of master teachers serving

program schools and bringing additional schools into the program each year, as well as management and accountability of the entire program.

Implementation of the Primary Mathematics Intervention Program (PMIP)

In order to be globally competitive, the pipeline must be fluid beginning in the elementary years with Kentucky's elementary schools providing a cohort of students interested in and prepared for rigorous math instruction. The Kentucky Department of Education already has a program that provides grants to train elementary school math teachers to provide specialized math instruction. The PMIP aims to facilitate proficiency by helping teachers understand better a child's current mathematics aptitude and adjust instruction to fit the child's learning style.

Using math achievement and assessment tools already in place as researched by a blue ribbon panel of university researchers, Kentucky is well equipped to scale this program statewide.

Desired Outcomes

Expansion of Project Lead the Way, AdvanceKentucky, and Primary Mathematics Intervention Program into Kentucky's public school systems utilizing postsecondary affiliates to provide aggressive teacher preparation through STEM specialist training engaging business, industry, and civic leaders throughout the regions. Utilization of best practice virtual learning technology with Web enhanced facilitation individually or in small groups will move this agenda forward with rigor and timeliness.

Challenge #3

Alignment of expectations is being met by the work of educational reformers with regard to math achievement and assessment. Aligning teacher preparation with elementary, middle and secondary school content with coordinated statewide curricula that emphasizes depth of knowledge is needed. Expansion into science and technology fields must follow and be integrated throughout the P-16 pipeline.

Expectations for every Kentucky student should be rigorous and uniform, regardless of their ambitions after high school. Every high school graduate in Kentucky must have the STEM skills to be college and workforce ready. This means aligning P-12 and postsecondary STEM instruction so that every Kentucky high school graduate is prepared for college/work/life. Models for math achievement and assessment are in place. Utilizing them to expand to science and technology must follow.

Strategy III

Utilize lessons learned from Math Achievement and Assessment work already developed and expand like models into Science and Technology curricula.

Desired Outcomes

Science and technology standards for teaching and learning achievement and assessment tools will be in place to provide evaluative measures in the STEM disciplines.

Challenge #3

Recruiting and retaining talented teachers are essential for Kentucky to attract classroom teachers prepared to provide students with world-class STEM instruction. Like many states, Kentucky loses too many current and potential teachers in these fields to private sector jobs with higher pay. Several national reports recommend dramatic change in teacher compensation as part of any solution to the STEM crisis. PLTW and AdvanceKentucky provide postgraduate training and incentives to recognize teaching excellence, including innovative compensation structures that provide salary supplements for additional training and expertise, bonuses tied to student performance, and college loan forgiveness. Removing impediments to alternative certification of teachers, including making changes to compensation strategies that allow second career teachers to earn salaries and benefits without penalty, are important next steps.

Strategy IV

Expand successful programs currently in place in Kentucky to increase recruitment and build teacher retention, scaled to other public and private postsecondary institutions engaging multiple sector partners.

Northern Kentucky University's Center for Integrative Natural Science and Mathematics (CINSAM). (http://cinsam.nku.edu/) is a program of distinction with measured success engaging college students in the teaching profession. The mission of CINSAM is to enhance the teaching, learning, and applying of science and mathematics through interdisciplinary collaboration. CINSAM is a Kentucky program with strategies addressing the barriers identified by research that will make a difference for many Kentuckians. Its goals are to prepare teachers for science and mathematics through pre-service opportunities among education, science, and mathematics faculty and their students and through in-service workshops and courses offered by the same faculty, with active involvement with science and mathematics alliances to provide opportunities for teachers to bring their students on-campus to work collaboratively with faculty. Scholarships for

students and teachers are made available fostering research opportunities. CINSAM's success is a model for implementation statewide.

Another successful partnership Teach Kentucky, (http://www.teachkentucky.com/default.aspx) recruits recent graduates from selective national institutions of postsecondary education to teach in Kentucky public schools. Teach Kentucky has forged a strategic partnership with the University of Louisville's College of Education and Human Development, Jefferson/Spencer/Henry and Shelby County Public Schools, and local alumni of the respective universities to fully engage recruits in the educational, social, and cultural fabric of communities.

Desired Outcomes

An increase in the number of STEM-disciplined college students pursuing teacher preparation courses of study and recruiting STEM professionals to engage in the teaching profession.

Challenge Summary

These challenges remain real time hurdles for Kentucky and the nation's economic times. Raising public awareness, providing opportunities, and encouraging professional development through the nationally recognized programs Project Lead the Way and AdvanceKentucky which acknowledges the need and reception of Kentucky school systems to change the way STEM disciplines are taught in an integrated and interdisciplinary approach will require partnerships with business, industry, and civic leaders across all sectors of the educational community in both time and resources. Kentucky legislative leadership is supportive of the efforts of reform in math achievement and assessment and has expressed their continued assistance with redirecting and expanding in like manner those efforts in science and technology. Utilizing Kentucky's strengths to address the technology focus areas for economic development, while preparing students for the future job market in energy-related business, health care, and telecommunications, afford opportunities to be creative and innovative in the approach to preparedness and economic growth. Utilizing the technology of virtual classrooms with engaged partners across a community or regional system of STEM educators is imperative to advancement.

Priority Recommendations and Budget

The following budget is an estimate of 1-3 year costs for STEM educational implementations as outlined above.

Priority Recommendations			Estimated Cost/Year
1.	Public Awareness and Promotion	STEM Web Site	$50,000
		STEM Summit(s)	$40,000
		Speakers Took Kit	$25,000
2.	Scale STEM Programs Statewide *	Project Lead the Way	$5,000,000
		AdvanceKentucky	$5,000,000
		Primary Mathematics Prevention Program	$1,000,000
3.	Scale Professional Alignment Statewide in Science & Technology	Science/Tech Achievement & Assessment Standards	$300,000
4.	Recruit & Retain Talented STEM Teachers	CINSAM modeled throughout Postsecondary institutions through engaged partner schools/business.	$300,000
		Teach Kentucky	$ 1,000,000
		TOTALS*	**$12,715,000**

*** Dependent upon re-directed PD funding and reduction in cost as scaled to state participation and phased in over a period of time as well as other sector contributions.**

Appendix I

STEM Task Force Steering Committee

Debbie Anderson, *Kentucky Department of Education*

Rodney Andrews, *Center for Applied Energy Research, University of Kentucky*

Keith Bird, *Kentucky Community and Technical College System*

Mary Ann Blankenship, *Kentucky Education Association*

Deborah Clayton, *Kentucky Cabinet for Economic Development*

Gary Cox, *Association of Independent Kentucky Colleges and Universities*

Richard Crofts, *Kentucky Council on Postsecondary Education*

Elaine Farris, *Kentucky Department of Education*

John Hindman, *Kentucky Cabinet for Economic Development*

Dan Kelly, *Kentucky State Senate*

Joanne Lang, *Kentucky Science and Technology Corporation*

Benny Lile, *Kentucky Association of School Administrators*

Nancy Martin, *Kentucky Rural Energy Consortium, University of Louisville*

Mike Ridenour, *Kentucky Chamber of Commerce*

Sheri G. Rose, *Kentucky Chamber of Commerce*

Bill Scott, *Kentucky School Boards Association*

Lee Todd, *University of Kentucky*

John Turner, *Kentucky Council on Postsecondary Education*

Phillip Rogers, *Education Professional Standards Board*

Harry Moberly, *Kentucky House of Representatives*

Jody Richards, *Kentucky House of Representatives*

Appendix II

Advisory Stakeholders

Jamie Bewley Byrd, *Kentucky Transportation Department*

Patrick Brewer, *Lexmark*

Bill Bush, *Center for Math Achievement, University of Louisville*

Sue Cain, *Eastern Kentucky University, Math Assessment*

Mason Dyer, *Association of Independent Kentucky Colleges and Universities*

Dale Elifrits, *CINSAM, Northern Kentucky University*

Blaine Ferrell, *Engineering Dean, Western Kentucky University*

Kirsten Fleming, *Kentucky Center for Mathematics, Northern Kentucky University*

Carol Hanley, *Girls STEM Collaborative, University of Kentucky*

Robin Hollinsgworth, *Parent Leadership Institute*

Henry Hunt, *DataSeam*

Darrell Ishmael, *East Kentucky Power*

William Kovacic, *Retired Engineer, Office of Surface Mining*

Yvonne Lovell, *GEAR Up*

David Magrane, *STEM Retired Faculty Emeritus, Morehead State University*

Shiela Medina, *Engineer, University of Kentucky Center for Applied Energy Research*

Allison Mefford, *Parent Leadership Institute*

Jan Muto, *Kentucky Community and Technical College System*

Julie Roberts, *Western Kentucky University*

Mark Ryles, *Kentucky Facilities Management*

Sue Scheff, *Girls STEM Collaborative*

Linda Sheffield, *Math Consultant*

Molly Toney, *Parent Leadership Institute*

Ruth Webb, *Kentucky Department of Education*

William Wilson, *KET Retiree*

John Yopp, *University of Kentucky*

Appendix III

Recommendations Template

Priority setting with ***estimated*** Time to Accomplish, Expected Outcomes, Evaluative Metrics & Measures, Responsible Partners and Costs follow.

1. STEM Public Awareness & Promotion							
	Recommendations	**Timeline**	**Outcomes**	**Metrics**	**Responsible**	**Year 1 Costs**	**Year 2+ Costs**
a.	Develop a STEM Web site as part of a communications' framework, creating awareness and encouraging involvement of all stakeholders.	1 Year	URL web address; Awareness by multiple stakeholders	Website visitors' utilization.	Education Community/ Kentucky Cities First/ Chamber of Commerce, other sector partners	$50,000	$50,000
b.	Develop brand and market to stakeholders.	3 Months	Establish Ky STEM brand	Established Ky STEM brand with multi-sector partner links.	Web development contractor/Ky Campus Compact	$10,000	
c.	Cross link with educators and community partners through education, business and government sectors.	6 Months - 1 year	Multiple sector links.	Link access from multiple sectors to STEM Education Opportunities/ Workforce Needs	Multi-sector web network administrators.		
d.	Aggressive media exposure of the STEM challenge and opportunities for success.	1 Year	Multi-sector partners promotion of Ky STEM information links coordinated with KnowHow2GOKy	Access to Ky STEM website to and from KHTG, multi source outlets.	CPE's KH2GKy, multi-sector partners.		

2. STEM Professional Training & Curricula Development/Alignment							
	Recommendations	**Timeline**	**Outcomes**	**Metrics**	**Responsible**	**Year 1 Costs**	**Year 2+ Costs**
a.	Develop a STEM professional development oversight consortium; utilize teacher surveys at all levels to identify preparedness needs, i.e. PEP survey online.	3 Months	Established consortium with mission & goals statement, with completed surveys and developed 1 year plan of work.	Survey completion and analysis with staged assessment of work plan.	EPSB, postsecondary education faculty/ admin, K-12 teachers/ admin, parents, et al.	TBD	
b.	Develop incentives for and recognitions of teaching excellence, including innovative compensation, i.e. loan repayment, dependent tuition, scholarships, internships, et al.	On-going with incentive/ reward programs in place within 3 years.	Established incentive and reward programs for STEM educator attainment.	STEM educator degree attainment with PRAXIS scores above national means; number of STEM educators attaining program incentive.	EPSB, KHEA, P-20 with stakeholder partnerships	TBD	
c.	Determine use of current professional development funds and opportunities for STEM educators. Promote the teacher ownership model of partnerships between K-12 teachers and Kentucky's college/university faculty for school and district specific professional development and math and science needs like the CINSAM, Primary Math Intervention Program (PMIP) and Partnership Enhancement Programs (PEP).	6 months	Documentation of STEM PD for K-12 teachers.	Fiscal reports on expenditures and unmet needs.	KDE, EPSB, Postsecondary Institutions	TBD	

2. STEM Professional Training & Curricula Development/Alignment *(Continued)*							
	Recommendations	**Timeline**	**Outcomes**	**Metrics**	**Responsible**	**Year 1 Costs**	**Year 2+ Costs**
d.	Promote Project Lead the Way and AdvanceKy teacher preparation for all STEM instruction.	On-going	Improved teacher preparation and student achievement; increase in number of teachers STEM "certified."	Student achievement scores/teacher needs identified.	All stakeholders	$5 million * cost shared by all sectors	
e.	Support curricula's structures that provide instruction in energy, biomedical sciences, agriculture and engineering with career and technical pathways; utilize virtual capacity through KYVHS, KYVC; Counseling and advising PD. Review dual credit and AP discrepancies.	On-going	Curricula that address global/state needs	Measure applications to employer needs.	KDE and PSIs, Virtual Campuses	TBD	

3. STEM Disciplines' Professional Development							
	Recommendations	**Timeline**	**Outcomes**	**Metrics**	**Responsible**	**Year 1 Costs**	**Year 2+ Costs**
a.	Education Professional Standards Board will provide navigator Web site linked to P-16 opportunities recognizing AdvanceKy CINSAM, PEPs, PLTW, PMIP, SKY Teach, and U-Teach methodologies for excellence.	On-going	See 1a and 1c above.	See 1a and 1c above.	EPSB	None	
b.	Align teacher preparation with elementary, middle, and secondary school content with coordinated statewide curricula, emphasizing depth of knowledge.	On-going	Aligned, transparent curricula.	Placement exams measuring student competencies at each level along a continuum.	KDE, Reading, Math, curriculum development - achievement committees	None	
c.	Incorporate National Board of Teacher Standards - teacher imperative to have system of accountability and uniform standards.	6 months	Incorporated standards into STEM-disciplined certification.	Kentucky's teacher preparation programs will document inclusion of NBPTS standards within EPSB approved programs.	EPSB	None	

4. STEM Community Engagement Partnerships							
	Recommendations	**Timeline**	**Outcomes**	**Metrics**	**Responsible**	**Year 1 Costs**	**Year 2+ Costs**
a.	Coordinate employer survey with Kentucky Society of Human Resource Managers to determine STEM workforce needs. As baseline date.	6 months	Analysis and determination of STEM workforce needs and system discussions of results.	Statistically significant validity of survey results.	Chamber of Commerce/KS HRM and KDE.	None	
b.	Coordinate current statewide P-16 STEM efforts (K-12, Girls STEM Initiative, KCTCS, and PSIs); address teacher retirement/retention as mentor/STEM specialists and/or trainers.	On-going	Address deficiencies in STEM preparation; persistence factors; interventions to improve performance; and increased STEM career pathway preparation.	Inclusion of partners in KCTCS STEM work group; improved performance in number of individuals in STEM career pathways.	P-20 STEM educators; KCTCS as lead.	None	
c.	Plan Regional/State STEM Leadership Summits with P-16.	1 year	Shared best practice pedagogy in STEM education.	Participant evaluations; demographic representation.	PSI, KDE, multi-sectors with New Cities Foundation	$40,000	
d.	STEM Leadership Group should determine measurement of success with partners and fiscal responsibility of state's expenditures on STEM. Further development continues with appropriate time/staff to further strategize.	On-going	Increase number of persons engaged in STEM-related fields meeting the workforce needs of Ky employers.	STEM degree productivity; STEM workforce employment		None	
e.	Develop Speakers' Toolkit for public partners' and coordinate statewide STEM Tour to raise awareness.	6 months	Toolkit for partners to utilize	Toolkit and incidents/location of use.	ALL stakeholders	$150,000	

5. STEM Education Funding							
	Recommendations	**Timeline**	**Outcomes**	**Metrics**	**Responsible**	**Year 1 Costs**	**Year 2+ Costs**
a.	Determine state's cumulative expenditures for STEM since reform.	6 months	Discipline specific expenditures as mandated by statute(s).	Analysis completed - report generated.	LRC, PSI researcher	None	
b.	Determine possible duplication of programs to eliminate those replaced by research-based programs.	6 months	Meta-analysis of STEM-related state programs in place.	Analysis completed - report generated.	Contractor	TBD	
c.	Determine availability of funds from various sources including local government, Appalachian Regional Commission, and Energy Workforce Development; and identify revenues that can be redirected.	6 months	Consolidation and fiscal efficiencies in place.		Contractor	TBD	
d.	Track efforts for outcomes via report card once measures are determined.	1 year	Ky STEM Education Report Card	Analysis completed - report generated. Interventions for improvement developed.	All Stakeholders	$510,000	

Appendix IV

Resources

ACT*. Ready for College and Ready for Work: Same or Different? 2006. *www.act.org/research/policymakers/pdf/ReadinessBrief.pdf*

ACT. Crisis at the Core: Preparing All Students for College and Work. 2004. *www.act.org/research/policymakers/pdf/crisis_report.pdf*

ACT. On Course for Success: A Close Look at Selected High School Courses That Prepare All Students for College and Work. 2004. *www.act.org/research/policymakers/pdf/success_report.pdf*

ACT. What are ACT's College Readiness Benchmarks? 2005.

ACT. Maintaining a Strong Engineering Workforce. 2003

ACT. On Course for Success: A Close Look at Selected High School Courses That Prepare All Students for College. 2005. *www.act.org/path/policy/index.html*

ACT. Developing the STEM Education Pipeline. 2006.

ACT. Meeting the Challenges of a Changing World. 2008.

ACT. Maintaining a Strong Engineering Workforce. 2003.

AdvanceKentucky. *http://www.kstc.com/?665*

Achieve Inc. American Diploma Project. Aligning High School Graduation Requirements with the Real World: A Road Map for States. 2007.

Achieve Inc. American Diploma Project. Ready or Not Creating a High School Diploma That Works. 2004

American Association of State Colleges and Universities. Developing Evidence and Gathering Data About Teacher Education Program Quality. 2007.

Coble, Charles R., et. al., Turning the Tide: Strategies for Producing the Mathematics and Science Teachers Our Schools Need. The National Association of System Heads, Washington, D.C. 2006. http:/www2.edtrust.org/NR/rdonlyres/7DCD6A7C-980C-4EA7-BE99-80D0EA3734AF/0/TurningTheTide.pdf.

Educational Testing Service. High School Reform and Work: Facing Labor Market Realities. 2006.

Educational Testing Service. Keeping Our Edge: Americans Speak on Education and Competitiveness. 2006.

Gates, Bill (Chairman, Microsoft Corporation), Bill Gates: U.S. Senate Committee Hearing on Strengthening American Competitiveness. Transcript of Oral Testimony before the United States Senate Committee on Health, Education, Labor, and Pensions "Strengthening American Competitiveness for the 21st Century." Washington, D.C., March 7, 2007. http://www.microsoft.com/Presspass/exec/billg/speeches/2007/03-07Senate.mspx.

Information Technology Industry Council. Fact Sheet - Promoting Math and Science Education: Keeping America Competitive. http://www.itic.org

Kentucky Council on Postsecondary Education Double the Numbers http://www.cpe.ky.gov/doublethenumbers/

Kentucky Council on Postsecondary Education. Science, Technology, Engineering, and Mathematics. Frankfort, Kentucky, http://cpe.ky.gov/info/stem.

Kentucky Legislative Research Commission. Senate Bill 2. KRS 164.0287. 2008

Kentucky Long Term Policy Research Center Report Emerging Global Workforce Raising Education Stakes, Children at the Economic Margins Key to Sustaining Progress, http://www.kltprc.net/foresight/no51.pdf

Kentucky Per Capita Income Analysis. SRI International, Arlington, VA, 2006.

KnowHow2GoKy. www.KnowHow2GoKy.org

National Center on Education and the Economy. Tough Choices or Tough Times, The Report of the New Commission on the Skills of the American Workforce. Jossey-Bass, San Francisco, December 22, 2006.

National Math and Science Initiative (NMSI). http://www.nationalmathandscience.org/

National Governors Association. Innovation America. NGA, Phoenix, AZ. 2006

National Science Board 2008, Science and Engineering Indicators 2008. http://www.nsf.gov/statistics/seind08/

Northern Kentucky University's Center for Integrative Natural Science and Mathematics (CINSAM). http://cinsam.nku.edu/

Primary Mathematics Intervention Program (PMIP), 2008. http://www.kentuckymathematics.org/intervention/intervention.asp

Primary Mathematics Intervention Program (PMIP) Successes, 2008. http://www.kentuckymathematics.org/research/research.asp

Project Lead the Way (PLTW). http://www.pltw.org/index.cfm.

Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future. The National Academies Press, Washington, D.C., February 2006 Edition.

Science and Engineering Indicators 2008 published by the National Science Board, provides a broad base of quantitative information on the U.S. and international science and engineering enterprise. http://www.nsf.gov/statistics/seind08/

Teach Kentucky. http://www.teachkentucky.com/default.aspx

Technology Counts 2008. www.edweek.org/go/tc08

Todd, Jr., Lee T., Solving Kentucky's STEM Crisis. The Courier-Journal, Louisville, KY, February 28, 2007.

U.S. Bureau of Labor and Statistics, Fastest growing occupations, 2004-14, http://www.bls.gov/emp

U.S. Department of Education National Center for Education Statistics. Highlights From TIMSS 2007: Mathematics and Science Achievement of U.S. Fourth- and Eighth-Grade Students in an International Context, 2007.
http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2009001

U.S. Department of Education National Center for Education Statistics. Dare to Compare.
http://nces.ed.gov/timss/

U.S. Department of Education National Center for Education Statistics, National Commission on Mathematics, and Science. Teaching for the 21st Century. 2008.

Visioning Kentucky's Future: Measures and Milestones 2006. Kentucky Long-Term Policy Research Center, Frankfort, Kentucky, 2006.

*ACT -The American College Testing Program, Inc., was founded in 1959 and in late 1996, they changed their name from American College Testing to ACT (pronounced "A - C - T") to reflect the commonly used name by students and educators around the world.

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STEM Documents: http://cpe.ky.gov/committees/stem/

STEM Report: http://cpe.ky.gov/stemreport2